

Real-Time Model-based Leak-Through Detection within Cryogenic Flow Systems

M. Walker, D2K Technologies

F. Figueroa, NASA Stennis Space Center

The timely detection of leaks within cryogenic fuel replenishment systems is of significant importance to operators on account of the safety and economic impacts associated with material loss and operational inefficiencies. Associated loss in control of pressure also effects the stability and ability to control the phase of cryogenic fluids during replenishment operations. Current research dedicated to providing Prognostics and Health Management (PHM) coverage of such cryogenic replenishment systems has focused on the detection of leaks to atmosphere involving relatively simple model-based diagnostic approaches that, while effective, are unable to isolate the fault to specific piping system components. The authors have extended this research to focus on the detection of leaks through closed valves that are intended to isolate sections of the piping system from the flow and pressurization of cryogenic fluids. The described approach employs model-based detection of leak-through conditions based on correlations of pressure changes across isolation valves and attempts to isolate the faults to specific valves. Implementation of this capability is enabled by knowledge and information embedded in the domain model of the system. The approach has been used effectively to detect such leak-through faults during cryogenic operational testing at the Cryogenic Testbed at NASA's Kennedy Space Center.